

The Christmas Island Seamount Province, Indian Ocean: Origin of intraplate volcanism by shallow recycling of continental lithosphere?

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The east-west-trending Christmas Island Seamount Province (CHRISP, 1800x600 km) in the northeastern Indian Ocean is elongated orthogonal to present-day plate motion, posing the question if a mantle plume formed this volcanic belt. Here we report the first age (Ar/Ar) and geochemical (Sr-Nd-Hf-Pb DS isotopic data) from the CHRISP seamount chain. A crude E-W age decrease from the Argo Basin (136 Ma), to the Eastern Wharton Basin (115-94 Ma) to the Vening-Meinesz seamounts (96-64 Ma) to the Cocos-Keeling seamounts (56-47 Ma) suggests spatial migration of melting. Christmas Island, however, yields much younger ages (44-4 Ma), inconsistent with an age progression. The isotopic compositions (e.g. $^{206}\text{Pb}/^{204}\text{Pb} = 17.3\text{-}19.3$; $^{207}\text{Pb}/^{204}\text{Pb} = 15.49\text{-}15.67$; $^{143}\text{Nd}/^{144}\text{Nd} = 0.51220\text{-}0.51295$; $^{176}\text{Hf}/^{177}\text{Hf} = 0.28246\text{-}0.28319$) range from enriched MORB (or "C") to very enriched mantle (EM1) type compositions more typical of continental than oceanic volcanism. Lamproitic and kimberlitic rocks from western Australia, India and other continental areas, derived from metasomatized subcontinental lithospheric mantle, could serve as the EM1 type endmembers. The morphology, ages and chemical composition of the CHRISP, combined with plate tectonic reconstructions, cannot be easily explained within the framework of the mantle plume hypotheses. We therefore propose that the seamounts are derived through the recycling of continental lithosphere (mantle \pm lower crust) delaminated during the breakup of Gondwana and brought to the surface at the former spreading centers separating Argoland (western Burma), Greater India and Australia.

Mercury colloid formation in a floodplain soil

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Understanding the biogeochemistry of mercury (Hg) in contaminated floodplain soils is essential for predicting potential Hg release induced by soil redox fluctuations. We studied Hg in the porewater of a surface soil collected in the contaminated floodplains of the river Mulde (Germany) during 26 days of flooding in laboratory microcosms. Porewater was sampled anoxically and analyzed for dissolved and colloidal Hg and other elements. Colloids collected on filter membranes (0.025 μm) were analyzed by X-ray absorption spectroscopy (XAS) at the Hg L3-edge at 30 K.

The concentrations of colloidal Hg increased rapidly upon soil flooding, peaked at 12 $\mu\text{g/L}$ at day 3, and decreased during subsequent sulfate reduction. Total Hg in the porewater was dominated by colloidal Hg over the duration of the experiment. We previously reported a similar behavior for Cu in soil from the same site [1]. The peak in colloidal Cu was shown to result from the formation of metallic Cu(0) nanoparticles associated with bacterial cells, followed by their transformation into Cu_xS colloids and the precipitation of dispersed Cu_xS nanoparticles upon sulfate reduction [1]. Hg EXAFS (extended X-ray absorption fine structure) spectra of colloids collected during the first 5 days of flooding exhibited oscillations, which indicated that Hg was incorporated in a highly crystalline structure. The spectra did not match any crystalline HgS reference, but were well described by a shell-fit based on a structural model for Hg-substituted Cu metal. This showed that colloidal Hg has formed by Hg(II) reduction and substitution of Hg(0) for Cu(0) in metallic Cu nanoparticles (molar Hg/Cu ratio ~ 0.002). Since metallic Cu increased to $\sim 14\%$ of total soil Cu within the first days of flooding [2], Hg-substituted Cu-metal likely also formed in the soil matrix. Like for Cu, subsequent sulfate reduction may have caused a transformation of Hg(0) into HgS, but colloidal concentrations were too low for Hg L3-edge XAS.

The formation of Hg-substituted Cu metal nanoparticles in soil is a novel finding with important implications for colloidal transport and volatilization of Hg in contaminated floodplains. Hg-substituted Cu metal nanoparticles may act as effective colloidal carriers for Hg release. On the other hand, incorporation of Hg(0) in Cu metal may impede the formation of volatile elemental Hg(0), which plays an important role for gaseous Hg release from contaminated floodplain soils.

[1] Weber *et al.* (2009) *Nature Geosci.* **2**, 267-271. [2] Weber *et al.* (2009) *Geochim. Cosmochim. Acta* 2009, **73**, 5513-5527.